

FIRST QUARTERLY REPORT

SI-ER-915

AD A 051 695

⑥ MANUFACTURING METHODS AND TECHNOLOGY PROJECT TO  
ESTABLISH PRODUCTION TECHNIQUES TO MANUFACTURE  
RIGID ARMOR FOR RADAR ANTENNA HARDENING.

⑨ REPORT PERIOD

1 JUN [REDACTED] 31 AUG [REDACTED] 77

⑫

4/4 P.

⑩ R. [REDACTED]

⑪ 52-117

TECHNICAL SUPPORT DIRECTORATE  
UNITED STATES ARMY ELECTRONICS  
RESEARCH AND DEVELOPMENT COMMAND  
FORT MONMOUTH, NEW JERSEY

⑯

PREPARED UNDER CONTRACT NO. DAAB07-77-C-0476

Approved for public release; distribution unlimited.

PREPARED BY



SWEDLOW, INC.

402 550  
12122 WESTERN AVENUE, GARDEN GROVE, CALIFORNIA 92645

D D C  
DRAFTED  
FEB 28 1978  
RECEIVED  
A -

mt

NOTICES

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

Destroy this report when it is no longer needed. Do not return it to originator.

This project has been accomplished as part of the US Army Manufacturing Methods and Technology Program which has as its objective the timely establishment of manufacturing processes, techniques or equipment to insure the efficient production of current or future defense programs.

## UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle)  MANUFACTURING METHODS AND TECHNOLOGY (MM&T) PROJECT TO ESTABLISH PRODUCTION TECHNIQUES TO MANUFACTURE RIGID ARMOR FOR RADAR ANTENNA HARDENING		5. TYPE OF REPORT & PERIOD COVERED  First Quarterly Report June 1, 1977 - August 1, 1977
7. AUTHOR(s)  R. Doerr		6. PERFORMING ORG. REPORT NUMBER  SI ER-915
9. PERFORMING ORGANIZATION NAME AND ADDRESS  Swedlow, Inc. 12122 Western Avenue Garden Grove, CA 92645		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS  TECHNICAL SUPPORT DIRECTORATE U.S. ARMY ELECTRONICS RESEARCH & DEVELOPMENT CMD FORT MONMOUTH, NEW JERSEY		12. REPORT DATE  JANUARY 1977
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		13. NUMBER OF PAGES  23 + A-1, A-2, B-1 multifold
		15. SECURITY CLASS (of this report)  UNCLASSIFIED
		15a. DECLASSIFICATION DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report)  Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)  Armor Panel Polymeric Radar Antenna Hardening		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number)  (See reverse side.)		

**UNCLASSIFIED**

**SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)**

**Block No. 20**

**ABSTRACT**

Manufacturing methods and technology to establish production techniques for fabrication of stretched, oriented, polypropylene film armor that is both RF transparent and fragment resistant are to be developed.

Prototype processing technology and evaluation procedures developed by the Army Materials and Mechanics Research Center are to be revised for use in production facilities with mass production equipment.

Radome panels are to be constructed to demonstrate the mass production capabilities, confirm production rates, and establish mass production plans to meet estimated military needs.

The project is to consist of preliminary sample panel fabrication to confirm physical and electrical characteristics, a pilot production run to confirm production rates, and an in-plant demonstration of production capabilities.

Reports are to be provided on all phases of production development through the pilot run. In addition, production studies and planning necessary for expansion to a mass production basis are to be provided.

A

**UNCLASSIFIED**

**SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)**

FIRST QUARTERLY REPORT

MANUFACTURING METHODS AND TECHNOLOGY PROJECT TO  
ESTABLISH PRODUCTION TECHNIQUES TO MANUFACTURE  
RIGID ARMOR FOR RADAR ANTENNA HARDENING

REPORT PERIOD

1 JUNE 1977 TO 31 AUGUST 1977

TECHNICAL SUPPORT DIRECTORATE  
UNITED STATES ARMY ELECTRONICS  
RESEARCH AND DEVELOPMENT COMMAND  
FORT MONMOUTH, NEW JERSEY

PREPARED UNDER CONTRACT NO. DAAB07-77-C-0476

Approved for public release; distribution unlimited.

PREPARED BY

  
**SWEDLOW, INC.**

12122 WESTERN AVENUE, GARDEN GROVE, CALIFORNIA 92645

ABSTRACT

Manufacturing methods and technology to establish production techniques for fabrication of stretched, oriented, polypropylene film armor that is both RF transparent and fragment resistant are to be developed.

Prototype processing technology and evaluation procedures developed by the Army Materials and Mechanics Research Center are to be revised for use in production facilities with mass production equipment.

Radome panels are to be constructed to demonstrate the mass production capabilities, confirm production rates, and establish mass production plans to meet estimated military needs.

The project is to consist of preliminary sample panel fabrication to confirm physical and electrical characteristics, a pilot production run to confirm production rates, and an in-plant demonstration of production capabilities.

Reports are to be provided on all phases of production development through the pilot run. In addition, production studies and planning necessary for expansion to a mass production basis are to be provided.

## CONTENTS

<u>SECTION</u>	<u>TITLE</u>	<u>PAGE</u>
1.0	PURPOSE AND INTRODUCTION . . . . .	1
1.1	Program Description . . . . .	1
1.2	Reports . . . . .	2
1.3	Schedule . . . . .	2
2.0	PANEL DESCRIPTION	
2.1	Size and Configuration . . . . .	4
2.2	Schedule of Panel Fabrication . . . . .	5
3.0	MANUFACTURING PROCEDURE . . . . .	7
4.0	INSPECTION AND TESTING PROCEDURES . . . . .	9
5.0	TOOLING AND PROCESSING EQUIPMENT	
5.1	General Description . . . . .	14
5.2	Armor Tooling . . . . .	14
6.0	PROBLEM AREAS AND PROPOSED SOLUTIONS . . . . .	19
6.1	Discontinuance of Manufacturing of Previously Tested Polypropylene Homopolymer . . . . .	19
6.2	Film Contaminates and Moisture Pick-up . . . . .	19
7.0	ACCOMPLISHMENTS DURING THIS QUARTER . . . . .	21
7.1	Program Review and Revision . . . . .	21
7.2	Facilities, Equipment and Manpower Evaluation . . . . .	21
7.3	Major Tool Design and Fabrication . . . . .	21
7.4	Accessory Tool Design . . . . .	21
7.5	Material and Process Evaluation . . . . .	21
8.0	SCHEDULE FOR THE NEXT QUARTER . . . . .	22
8.1	Oriented Film Processing and Delivery . . . . .	22
8.2	Oriented Film Evaluation . . . . .	22
8.3	Protective Film Processing and Evaluation . . . . .	22
8.4	Major Tool Delivery . . . . .	22
8.5	Material Procurement . . . . .	22
8.6	Material and Process Evaluation . . . . .	22
REFERENCES	. . . . .	23
APPENDIX		
A	DRAWINGS	
	Swedlow Drawing No. 77016 - Mold Die Assembly . . . . .	A-1
	Swedlow Drawing No. 77013 - Mold Support . . . . .	A-2
B	PERT CHART, REVISION A . . . . .	B-1

## LIST OF ILLUSTRATIONS

<u>DRAWING NO.</u>	<u>TITLE</u>	<u>PAGE</u>
1	Program Schedule for Major Events . . . . .	3
2	Cross-Plying . . . . .	5
3	Manufacturing Flow Diagram . . . . .	8
4	Tooling and Processing Equipment Flow Chart . . .	15
5	Mold Die Configuration . . . . .	16
6	Shearing Off the Bag . . . . .	17

## TABLES

<u>TABLE NO.</u>	<u>TITLE</u>	<u>PAGE</u>
I	Component Material Test Requirements . . . . .	10
II	Armor Panel Test Requirements . . . . .	12

## **1.0    PURPOSE AND INTRODUCTION**

The purpose of this program is to establish production techniques and production capabilities for the manufacture of armor panels. The armor panels are intended for use with flat radar antennas to provide protection from munitions fragments.

The armor panels will be flat molded sheets of various sizes and edge finishes. The sheets will be molded from cross-plied assemblies of unidirectionally oriented, blown film made from a dielectric grade polypropylene. A protective overlay will be molded into the panel surfaces and camouflage will be incorporated in or onto a portion of the panels.

### **1.1    Program Description**

The program is divided into four tasks as described below:

#### **Task 1    Engineering Samples**

Two sets of two each panels will be produced in order to demonstrate the ballistic capabilities of the selected materials and processes.

#### **Task 2    Confirmatory Samples**

Ten sets of two each panels of various sizes, thicknesses, and camouflaging methods will be produced in order to demonstrate the total capabilities of the panels in regard to environmental stability, electronic transmission, and ballistic characteristics. In addition, camouflaging techniques and panel trim and edge fusing will be demonstrated.

#### **Task 3    Pilot Run**

Thirty-two sets of two each panels will be produced in order to demonstrate the capacity of each production step and to verify the capability of the line to fabricate at an acceptable rate.

#### **Task 4    Production Capability Demonstration**

An in-plant demonstration will be held in order to show the production capabilities of the pilot production line to invited representatives of industry and government.

## 1.2 Reports

In addition to the quarterly report the following reports are to be provided during the course of the contract.

### 1) Engineering Sample Test Reports

Mechanical and electronic test reports documenting engineering sample testing.

### 2) Confirmatory Sample Test Reports

Mechanical and electronic test reports documenting confirmatory sample testing.

### 3) Preliminary Pilot Run Report

A preliminary report on the capability of the pilot line.

### 4) Production Rate Flow Chart

A description of the process, tooling, capacity, yield, and labor requirements of each operation of the pilot run.

### 5) Production Demonstratio· Plan

A report to inform the industry at large of the activities and accomplishments of the program.

### 6) Final Report Step I

Final engineering report covering project activities from start of the contract through pilot run panel fabrication and evaluation.

### 7) General Report Step II

A report covering the manpower, facilities, equipment and tooling requirements necessary for a production rate of 200 units per 40 hour week.

## 1.3 Schedule

The program schedule for major events is presented in Figure 1.

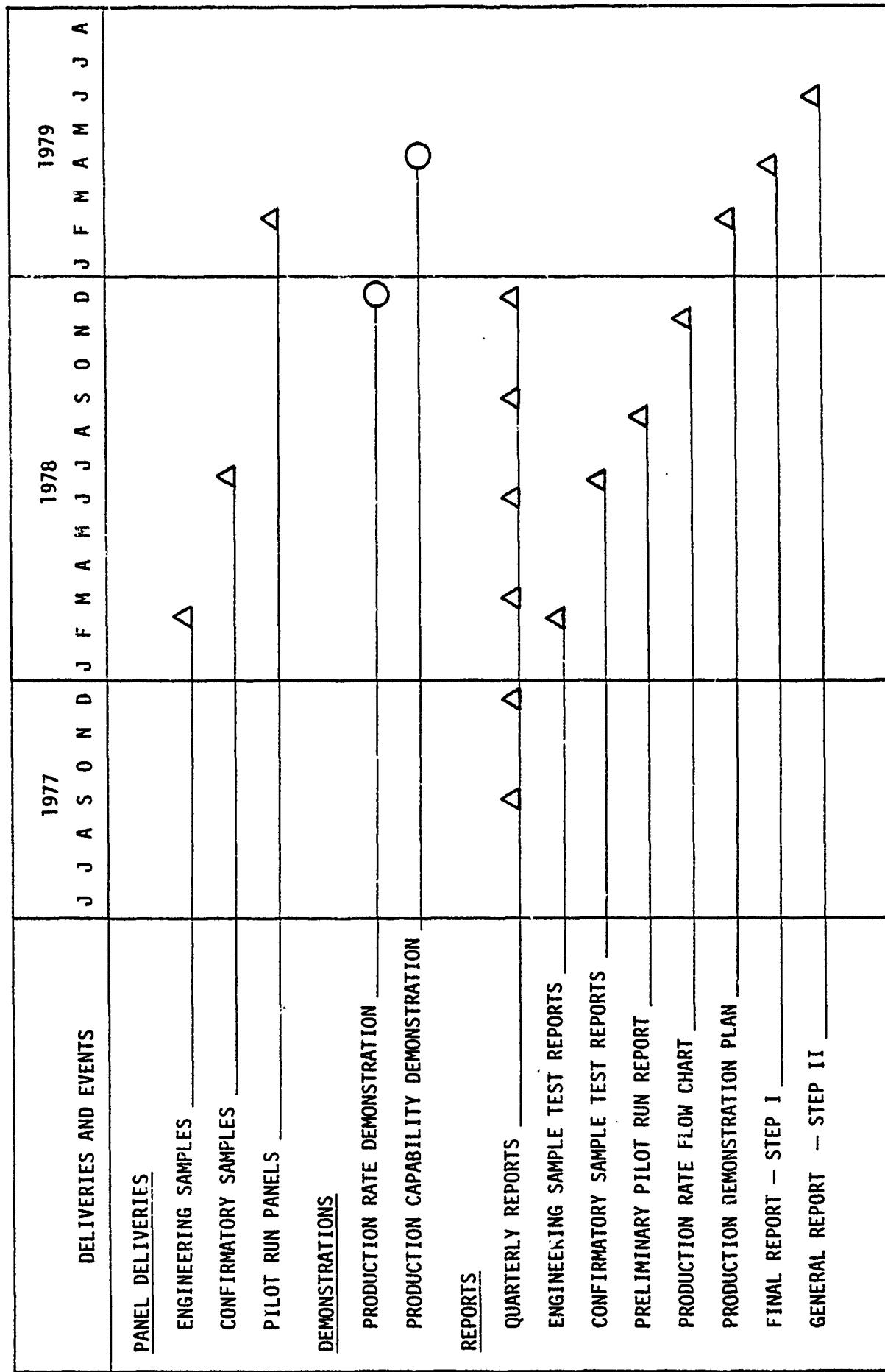


Figure 1. Program Schedule for Major Events

2.0 PANEL DESCRIPTION

2.1 Size and Configuration

Panels will be compression molded in a matched steel mold in two thickness with the same length and width. Nominal sizes are 1" x 32" x 42" and 3/8" x 32" x 42".

Different edge finishes will be provided by trimming and edge fusing molded panels.

Camouflage patterns will be provided by molding on printed film, attaching printed film with contact adhesive, and painting molded panels.

The following is a summary of panel configurations and sizes.

Size 1 - 1.045  $\pm$  .015 inch thick

Size 2 - 0.375  $\pm$  .015 inch thick

Finish 1 - Edge as molded. Panel size to be 32  $\pm$  .07 inch x 42  $\pm$  .07 inch

Finish 2 - Edge cut and fused. Final panel size to be 30  $\pm$  1/32 inch x 40  $\pm$  1/32 inch

Style 1 - Natural (protective film only - no camouflage)

Style 2a - Molded in camouflage

Style 2b - Contact adhesive applied camouflage

Style 2c - Painted camouflage

The panels will be made up of cross plied oriented polypropylene films drawn 12:1. Nominal oriented film size will be .0015 inches x 8 inches. Cross plying will be shoulder to shoulder, or butt wound as shown in Figure 2.

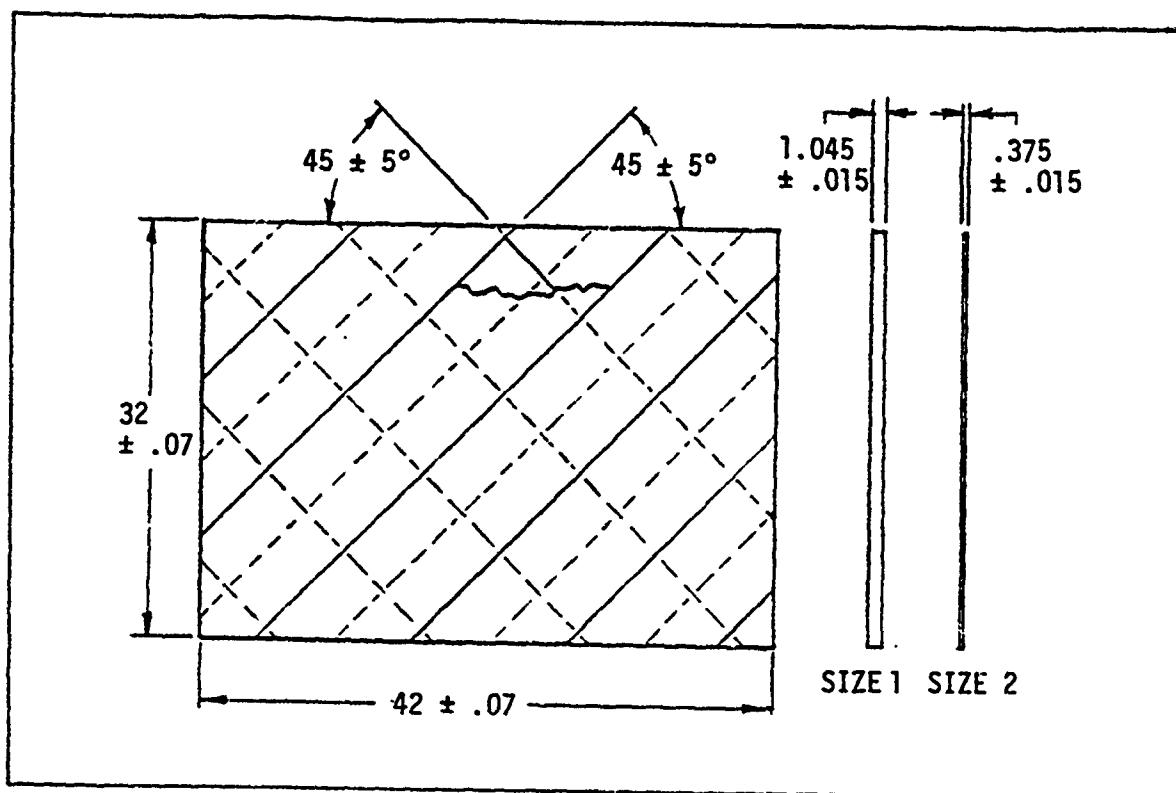


Figure 2. Cross-Plying

## 2.2 Schedule of Panel Fabrication

During the course of the program, the following panel configurations will be fabricated:

**Engineering Samples - (4) Armor Panels**

2 each Size 1, Style 1, Finish 1

2 each Size 2, Style 1, Finish 1

**Confirmatory Samples - (20) Armor Panels**

2 each Size 1, Style 1, Finish 1

2 each Size 1, Style 2a, Finish 1

**Confirmatory Samples - Continued**

2 each Size 1, Style 2b, Finish 1  
2 each Size 1, Style 2c, Finish 1  
2 each Size 1, Style 1, Finish 2  
2 each Size 2, Style 1, Finish 1  
2 each Size 2, Style 2a, Finish 1  
2 each Size 2, Style 2b, Finish 1  
2 each Size 2, Style 2c, Finish 1  
2 each Size 2, Style 1, Finish 2

**Pilot Run - (64) Armor Panels**

32 each Size 1  
32 each Size 2

Style and finish to be determined after confirmatory sample evaluation.

**Production Capability Demonstration**

Quantity and configuration as required to demonstrate production methods.

### **3.0 MANUFACTURING PROCEDURE**

The armor panel manufacturing procedure can be divided into four major processing steps.

- Step 1**      Extrude and orient polypropylene film
- Step 2**      Cross-ply film, assemble, and trim
- Step 3**      Precondition assembly, mold panels, and post condition panels
- Step 4**      Trim and edge fuse or apply camouflage as required

Figure 3 shows the detailed manufacturing steps needed to fabricate panels of various edge finishes and styles as a flow diagram.

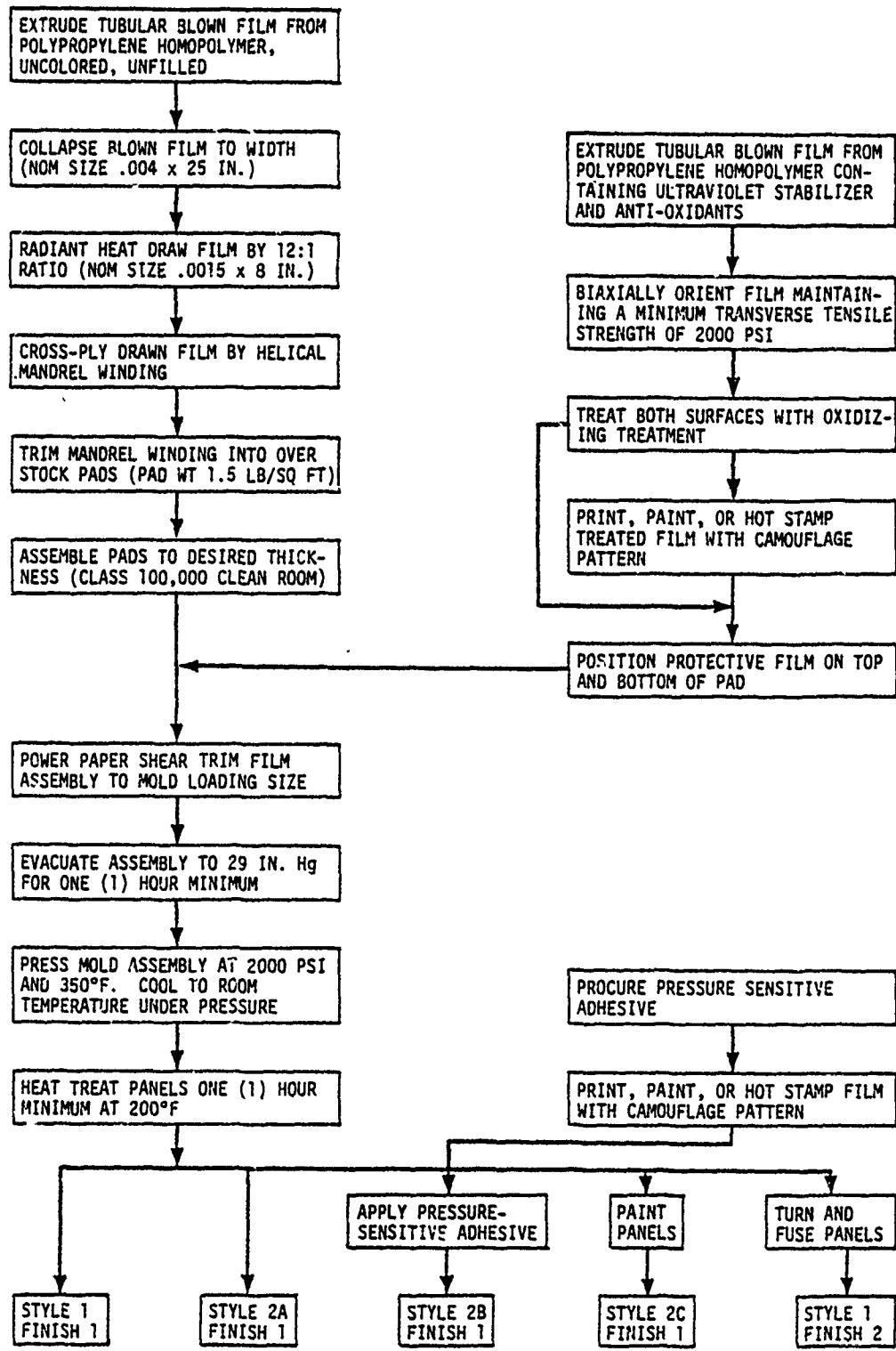


Figure 3. Manufacturing Flow Diagram

#### **4.0 INSPECTION AND TESTING PROCEDURES**

The primary inspection and testing tasks involve the ballistic, electronic, and dimensional stability testing of the completed armor panels. However, all raw materials that make up these panels will be subjected to physical and electrical testing.

All armor panels will be tested for frequency characteristics, sizes, and tolerances, edge finish and soundness (non-destructive tests).

Tests for camouflage and dimensional stability will be performed on one of each size - style - finish combination and ballistic tests will be performed on the other panel of that set (destructive tests).

Table I lists tests required and requirements for all component materials.

Table II lists tests required and requirements for armor panels. Tests are to be performed on engineering samples, confirmatory samples and pilot run panels.

TABLE I. COMPONENT MATERIAL TEST REQUIREMENTS

Sheet 1 of 2

MATERIAL	TESTS REQUIRED	TEST PROCEDURE	REQUIREMENTS
<u>1) Basic Materials</u>			
Polypropylene resin	Physical properties Dielectric constant Loss tangent	ASTM D 2146-69 ASTM D 2520-70 ASTM D 2520-70	Per ASTM D 2146-69 2.3 or less 0.0005 or less
Protective overlay	Physical properties  Accelerated weathering	ASTM D 2673-69  FED-STD-191 Method 5804 for 200 hours	Per ASTM D 2673-69 and minimum transverse tensile strength of 2000 psi  Retention of 90 percent of tensile strength and elongation
Protective overlay with camouflage	Physical properties  Accelerated weathering Camouflage.	ASTM D 2673-69  FED-STD-191 Method 5804 for 200 hours  MIL-E-52798 and sample pattern	Per ASTM D 2673-69 and minimum transverse tensile strength of 2000 psi  Retention of 90 percent of tensile strength and elongation  Per MIL-E-52798 and sample pattern
Pressure-sensitive adhesive coated film	Tensile strength and elongation	FED-STD-101 Method 2063	Tensile strength of 30 lbs per inch of width and 500 percent elongation minimum
Paint	Adhesive strength Camouflage	FED-STD-101 Method 2050  MIL-E-52798	30 ounces per inch of width minimum  Per MIL-E-52798

TABLE I. COMPONENT MATERIAL TEST REQUIREMENTS (Cont)

Sheet 2 of 2

MATERIAL	TESTS REQUIRED	TEST PROCEDURE	REQUIREMENTS
2) <u>Intermediate Materials</u>			
Tubular blown film	Thickness width	ASTM D 374-74 Method C Standard	$0.0044 \pm .0004$ inch Range of 24 to 27 inches, tolerance $\pm 1/4$ inch
Oriented films	Orientation release stress  Temperature of maximum stress	ASTM D 1504-70	1900 psi minimum average 1700 psi minimum individual
	Thickness	ASTM D 1504-70	345°F minimum average 340°F minimum individual
	Width	ASTM D 374-74 Method C Standard	.0015 maximum average .0020 maximum individual None - record
	V <sub>50</sub> Ballistic Limit	MIL-STD-662A	(Classified)

TABLE II. ARMOR PANEL TEST REQUIREMENTS

Sheet 1 of 2

MATERIAL	TEST REQUIRED	TEST PROCEDURE	REQUIREMENTS
1) <u>Non-destructive</u> <u>Tests</u>	Size & tolerance Edge finish Soundness S-Band Frequency Characteristics	Standard Standard Standard (Classified)	<p>Size 1 Finish 1 .375 ± .015 x 32 ± .07 x 42 ± .07</p> <p>Size 2 Finish 1 1.045 ± .015 x 32 ± .07 x 42 ± .07</p> <p>Size 1 Finish 2 .375 ± .015 x 30 ± .032 x 40 ± .032</p> <p>Size 2 Finish 2 1.045 ± .015 x 30 ± .032 x 40 ± .032</p> <p>No splits, delaminations greater than .060, or raised lips greater than .030</p> <p>Translucent and free of edge splits, voids, unbonded areas, and blisters (Classified)</p>
2) <u>Destructive</u> <u>Tests</u>	One panel of each size - style - finish set	Dimensional stability	<p>Humidity cycle in test chamber (60 Hrs. total) Per PD-105 Section 4.2.5</p> <p>No splits or delaminations. Maximum length or width change 0.40 inch decrease. Maximum thickness change 0.010 inch increase. Maximum change in warpage 0.06 inch increase.</p>

TABLE III. ARMOR PANEL TEST REQUIREMENTS (Cont)

Sheet 2 of 2

MATERIAL	TEST REQUIRED	TEST PROCEDURE	REQUIREMENTS
<u>2) Destructive Tests</u> Continued			Per MIL-E-52798 and standard sample (classified)
Camouflage		MIL-E-52798 and standard sample	
Other panel of each size - style - finish set	V <sub>50</sub> Ballistic Limit	MIL-STD-662A	ASTM D2520-70 2.3 or less
One specimen of each style molded to dimensions required following panel procedure including, except for style 1, the incorporation of camouflage	Dielectric constant at 50 ± 5 percent relative humidity	ASTM D2520-70 Loss factor at 50 ± 5 percent relative humidity	0.0005 or less

## 5.0 . TOOLING AND PROCESSING EQUIPMENT

### 5.1 General Description

Manufacture of the armor panels involving a series of processing steps through various types of processing equipment that function independently or in conjunction with specific armor tools.

The multi-purpose processing equipment such as film extruders, presses, and ovens are capitalized equipment that have various and continuing manufacturing uses.

The armor tooling is designed specifically for armor panels processing.

Figure 4 shows a schematic flow of the armor through the processing equipment and special tools.

### 5.2 Armor Tooling

The following is a brief description of the armor tooling describing the intended use and special tooling features.

#### Anti-Static Attachment

The anti-static device consists of two bar type static eliminators mounted just forward of the mandrel winding take-off film roll and positioned on either side of the oriented film.

These units will neutralize the static charge on the film and prevent the pick up of dust or any other floating air contaminates.

#### Caul Plates

The caul plates are .050 thick stainless steel plates that are placed on either side of the assembled cross-plied film either just before or just after trimming to net size for molding.

The caul plates help hold the cross-plied material in position during evacuation and mold loading. They are removed from the part after molding and cool-down.

#### Power Shear

The power shear is a standard power paper shear modified for special hold down requirements for plastic film shearing.

The power shear cuts the assembled, cross-plied film to net molding size.

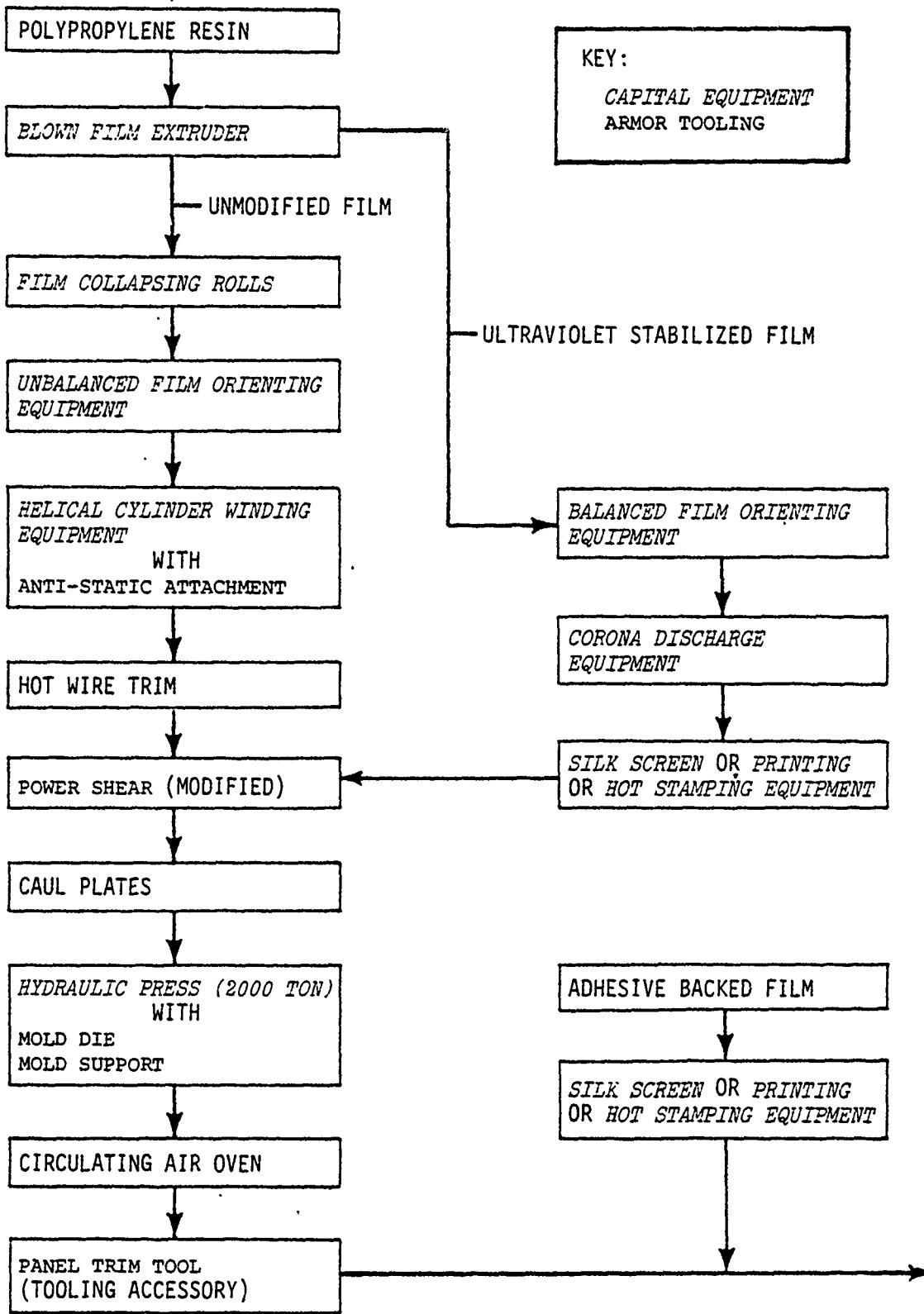


Figure 4. Tooling and Processing Equipment Flow Chart

### Mold Die

The mold die is a matched steel die used to contain the cross-ply assembly during the lamination cycle. It is a semipositive compression mold with a steam heating - water cooling chamber on either side. It has guide pins and bushings for alignment and stop blocks for thickness control.

Figure 5 shows a sketch of the mold die. See Appendix A, Swedlow Drawing No. 77016 - Mold Die Assembly.

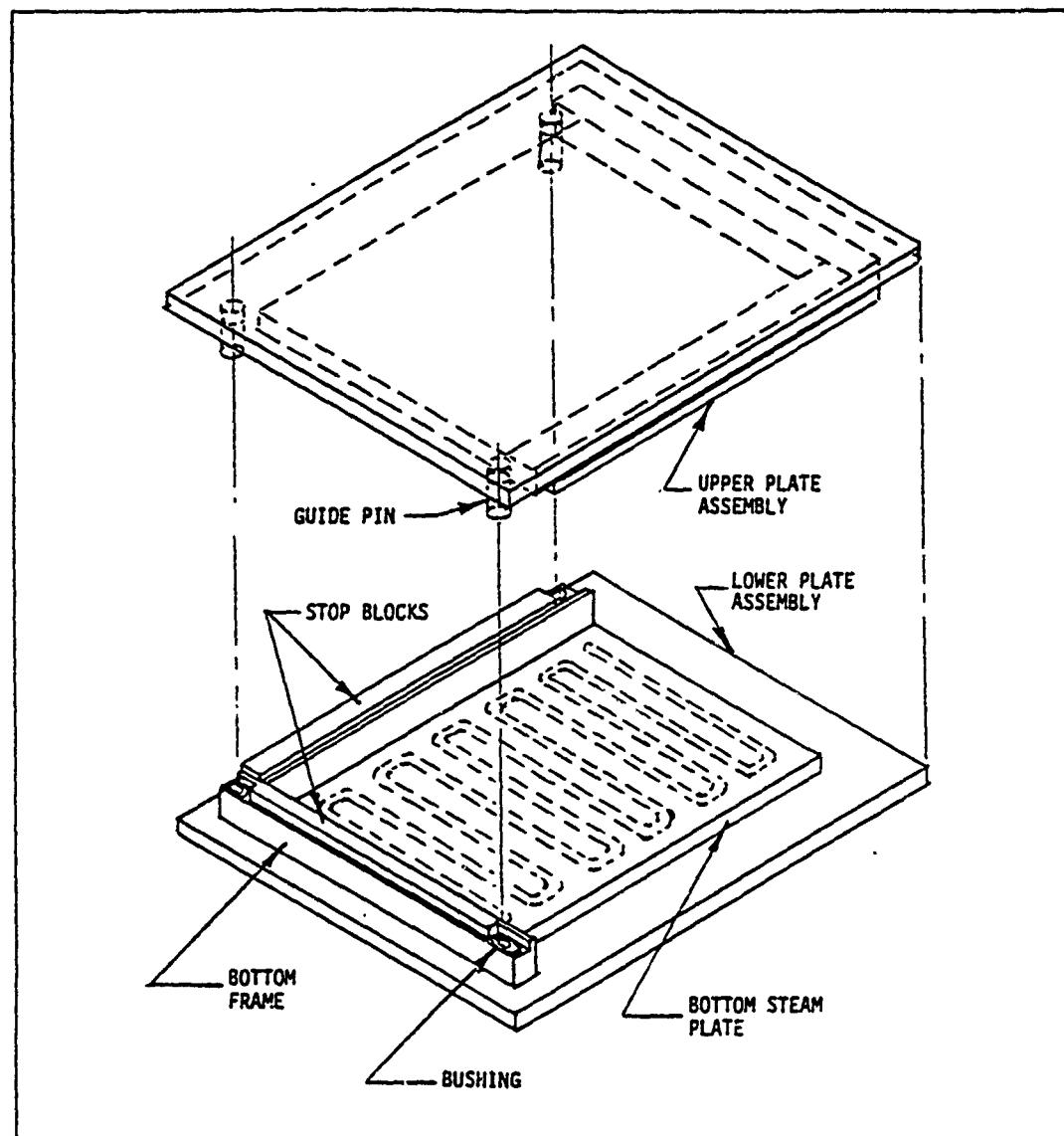


Figure 5. Mold Die Configuration

The mold die has the following features:

- 1) The top and bottom halves of the die are mirror images with all components of the same size and thickness. This provides for a balanced heat input and uniform cool-down.
- 2) The die containment frame is split between top and bottom die halves. This arrangement allows ease of loading and unloading without side frame removal.

In addition, it accommodates loading of a bagged assembly shearing off the bag during mold close, as shown below in Figure 6.

- 3) The side bars are bolted and doweled onto the base plate. This arrangement allows for ease of die rework if length and width dimensional tolerances are not met.  
Stop block control of shut height also allows for ease of rework if thickness tolerances are not met.
- 4) The location and close spacing of the steam - water passages will provide rapid and uniform heat-up and cool-down.
- 5) All working surfaces will be chrome plated for corrosion resistance.

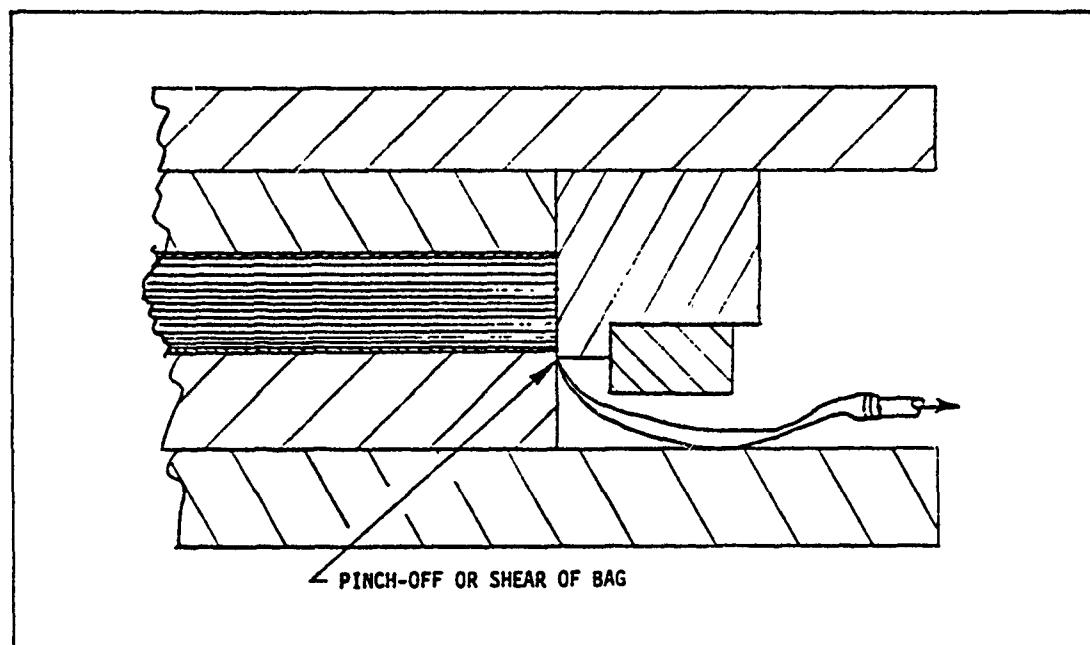


Figure 6. Shearing Off the Bag

### Mold Support

The mold support is a steel weldment needed in order to achieve full press closure. See Appendix A, Swedlow Dwg No. 77013 - Mold Support.

### Panel Trim Tool

The panel trim tool will consist of a hold down frame to firmly restrain the panel during final trim and fusion.

### Other Accessory Tools

Other accessory tools will be handling and holding aids, as needed, at the various processing steps.

## 6.0 PROBLEM AREAS AND PROPOSED SOLUTIONS

Problem areas and potential problem areas along with proposed solutions are discussed in the following paragraphs.

### 6.1 Discontinuance of Manufacturing of Previously Tested Polypropylene Homopolymer

The basic polypropylene resins used in the preliminary AMMRC laboratory-scale and prototype testing programs has been discontinued by the manufacturer Phillips Chemical Co. The successor of this film has not as yet been fully evaluated to assure completely satisfactory processing, physical, and electronic characteristics.

#### Solution:

The program has been rescheduled to allow sufficient time for evaluation of the successor film.

### 6.2 Film Contaminates and Moisture Pick-up

As contaminates and moisture pick-up would result in poor bonding and subsequent delaminations during dimensional stability testing, special precautions for their prevention and elimination are required.

#### Solutions:

Materials will be packaged and stored in such a manner so as to prevent contamination and moisture pick-up between processing steps.

Anti-static bars will be used to neutralize the static charge on the film at the winding operation and thus prevent pick-up of floating contaminates.

All film handling will be done with clean dry cotton gloves.

Assembly of the film will be done in a Class 100,000 or better clean room.

Polypropylene film plies that come into contact with protective covers or separators will be removed and discarded.

Moisture pick-up problems will be eliminated by heating the assembly during evacuation prior to molding.

### Air Entrapment

As air entrapment will also result in poor bonding and degradation of both physical and electronic properties, effective evacuation procedures must be developed. At the same time excessive evacuation time in the mold die will tie up a major piece of processing equipment and increase the duration of a critical processing step.

Initial laboratory work by AMMRC indicates that air entrapment can not be eliminated without an evacuation procedure.

Using the philosophy of proceeding from the simple to the more complicated, the following processing methods will be tried sequentially.

#### Solutions:

- 1) The assembly will be vacuum bagged and evacuated for 15 hours minimum prior to molding. The assembly will be removed from the vacuum bag just prior to loading into the mold.
- 2) The assembly will be bagged and evacuated for 15 hours minimum prior to molding. The bagged assembly will then be loaded into the mold and the vacuum maintained as the mold closes and shears off the bag (see Figure 6).
- 3) The assembly will be vacuum bagged and evacuated for 15 hours minimum prior to molding. The assembly will be removed from the vacuum bag just prior to loading into the mold die. The assembly will then be re-evacuated in the mold die and held for one-half hour minimum prior to mold closure and during closure and cure.

### Delamination During Panel Trimming

As trimming finished panel edges without inducing delamination is difficult, special tooling, equipment and procedures will be required.

#### Solution:

A high pressure hold down system will be developed to prevent delamination during trimming and fusion operations.

7.0 ACCOMPLISHMENTS DURING THIS QUARTER (June, July, August, 1977)

Accomplishments during the first three months are outlined below.

7.1 Program Review and Revision

A review of the program covering materials, processing, and testing requirements was completed this period.

During the review of material requirements, the problem of the untested successor to the previously manufactured polypropylene resin surfaced. The schedule was revised to allow sufficient time to evaluate the successor material.

The review information was formalized into a PERT schedule (Program Evaluation and Review Techniques). The PERT schedule has been revised to reflect the above schedule change (see Appendix B - PERT Chart Revision "A").

7.2 Facilities, Equipment and Manpower Evaluation

The facilities, equipment and manpower requirements of the program were analyzed and all program requirements were scheduled.

7.3 Major Tool Design and Fabrication

The major tools including the mold die and the mold support were designed and fabrication of these tools by outside vendors was started. See Appendix A, Swedlow Drawings No. 77013 and 77016.

7.4 Accessory Tool Design

The accessory tools with the exception of the final panel trim tool, handling and holding fixtures were designed and scheduled for fabrication.

7.5 Material and Process Evaluation

Material and/or processing method evaluation was started in the following areas.

- a) Trim and edge fusion process development
- b) Protective film selection
- c) Adhesive backed film selection
- d) Camouflage material selection
- e) Camouflage material application process development

8.0 SCHEDULE FOR THE NEXT QUARTER (September, October, November, 1977)

The program schedule for the next three months is outlined below.

8.1 Oriented Film Processing and Delivery

The initial order of the oriented film is scheduled for delivery at the end of September. This will be sufficient material for film evaluation, process development, and for fabrication of the Engineering Sample Panels.

8.2 Oriented Film Evaluation

Evaluation of the oriented film for mechanical properties, electrical properties, electronic properties, and ballistic properties will be started as soon as the material is received.

This testing is scheduled for completion the first week in December.

8.3 Protective Film Processing and Evaluation

The protective film is scheduled to be run in October and evaluation will be started as soon as the film is received.

8.4 Major Tool Delivery

The mold die and mold support are scheduled for delivery at the end of October and will be inspected upon receipt.

8.5 Material Procurement

The balance of the oriented film and the total program order for cross-plied pads are scheduled for ordering in the last month of this period (November).

8.6 Material and Process Evaluation

The protective film, adhesive backed films, and camouflage materials selection and process development will be continued through the next three month period.

## REFERENCES

### REPORTS

1. Prifti, De Luca, and Alesi, "Hardened Tuned-Wall Plastic Radomes for Military Radars (U)", Army Materials and Mechanics Research Center, Watertown, Massachusetts.
2. Alesi, Ames, Gagne, Litman, and Prifti, "New Materials and Construction for Improved Helmets", Army Materials and Mechanics Research Center, Watertown, Massachusetts, AMMRC MS 75-9.

### SPECIFICATIONS

AMMRC-PD-105	Technical Requirements Armor, Panel, Polymeric, Radar, Antenna Hardening
ECIPPR No. 15	Manufacturing Methods and Technology (MM&T) for Components, Materials and Processes
MIL-E-52798	Enamel, Alkyd, Camouflage

### STANDARDS, MILITARY AND FEDERAL

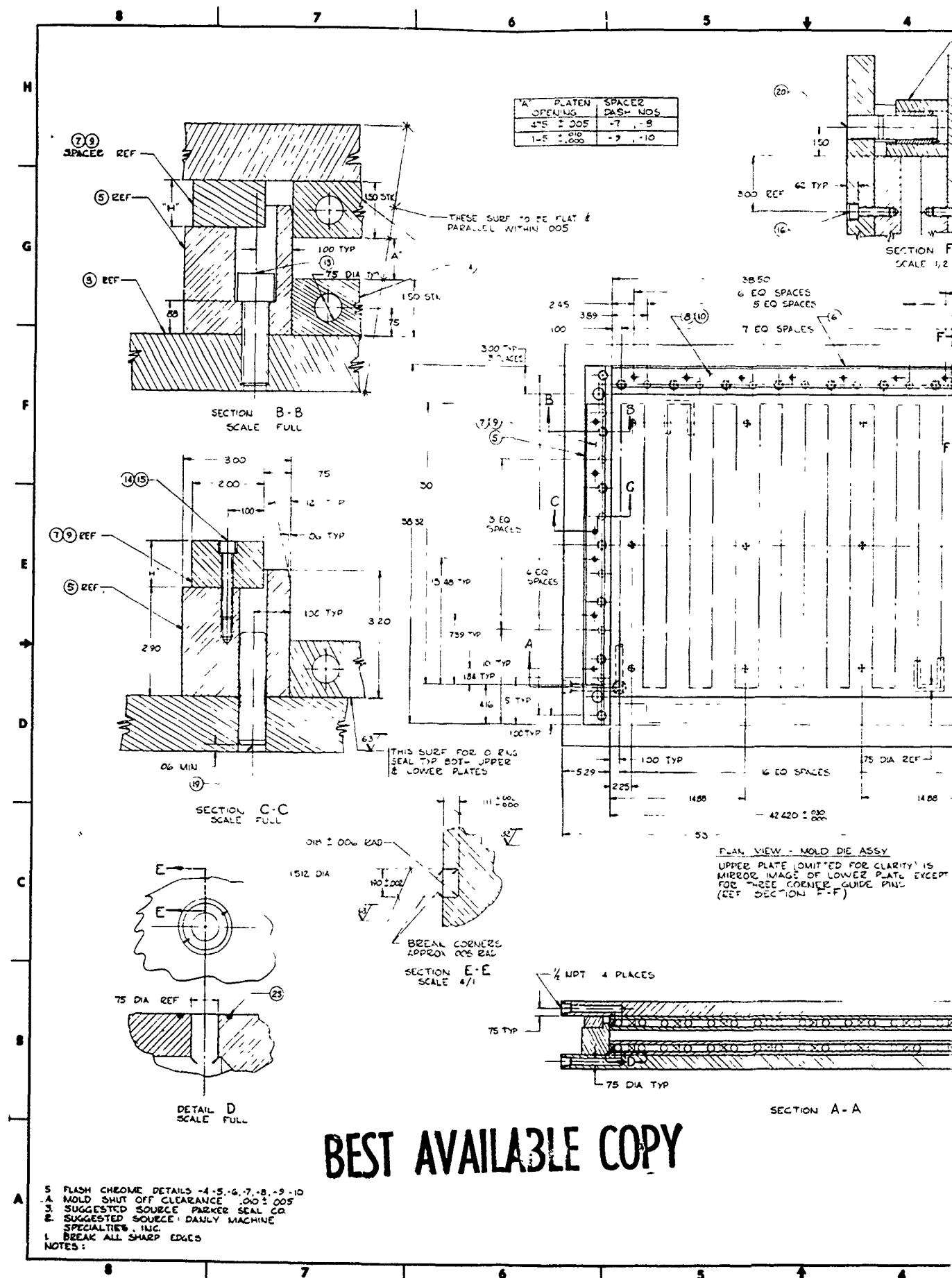
MIL-STD-662	Ballistic Acceptance Test Method for Personnel Armor
FED-STD-101	Preservation, Packaging and Packing Materials, Test Procedures
FED-STD-191	Textile Test Methods

### STANDARDS, INDUSTRY

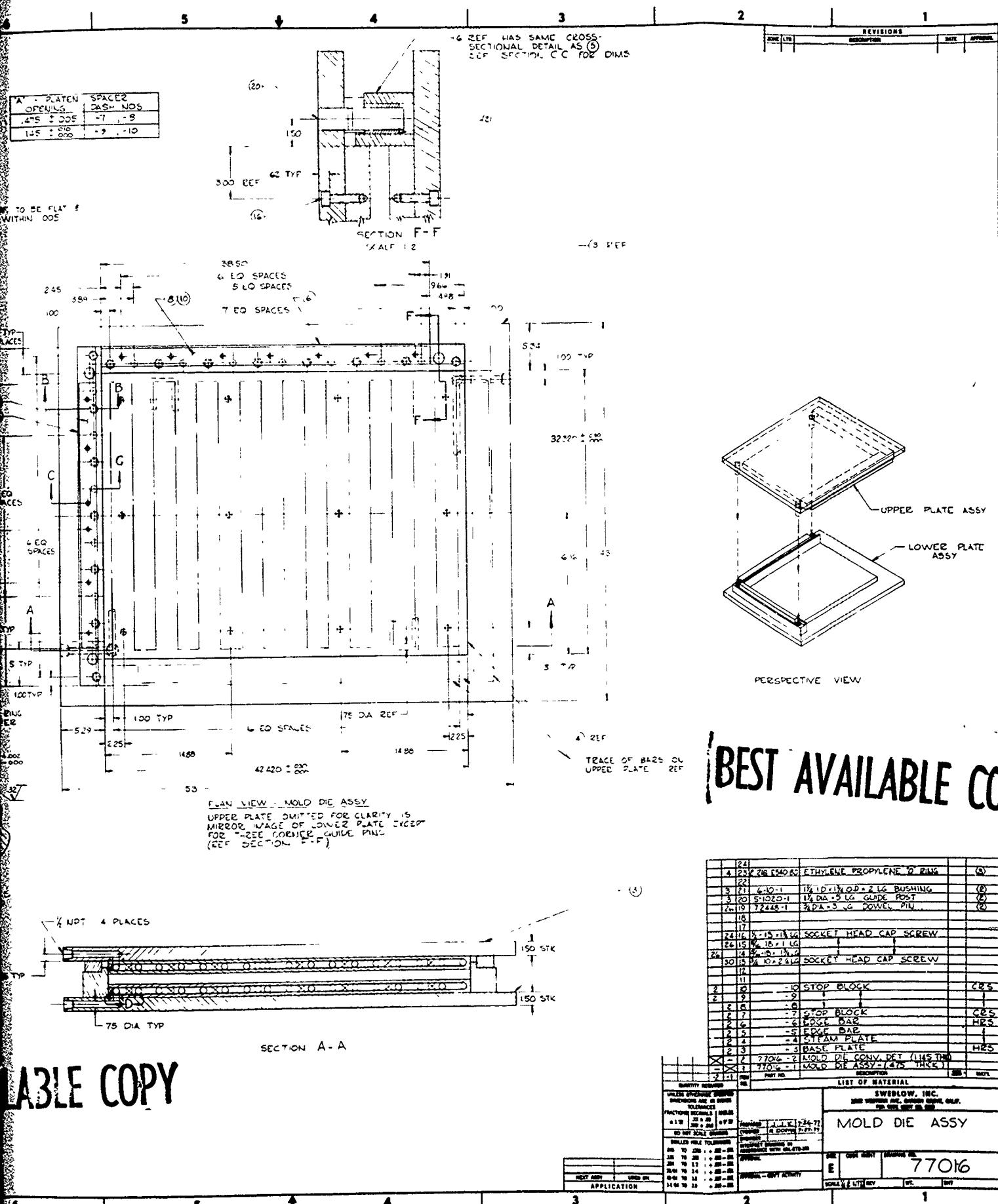
ASTM D 374-74	Thickness of Solid Electrical Insulation
ASTM D 1504-70	Determining Orientation Release Stress of Plastic Sheeting
ASTM D 2146-69	Propylene Plastic Molding and Extrusion Materials
ASTM D 2520-70	Complex, Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials at Microwave Frequencies and Temperatures to 1650°C
ASTM D 2673-69	Oriented Polypropylene Film

**APPENDIX A**

**DRAWINGS**

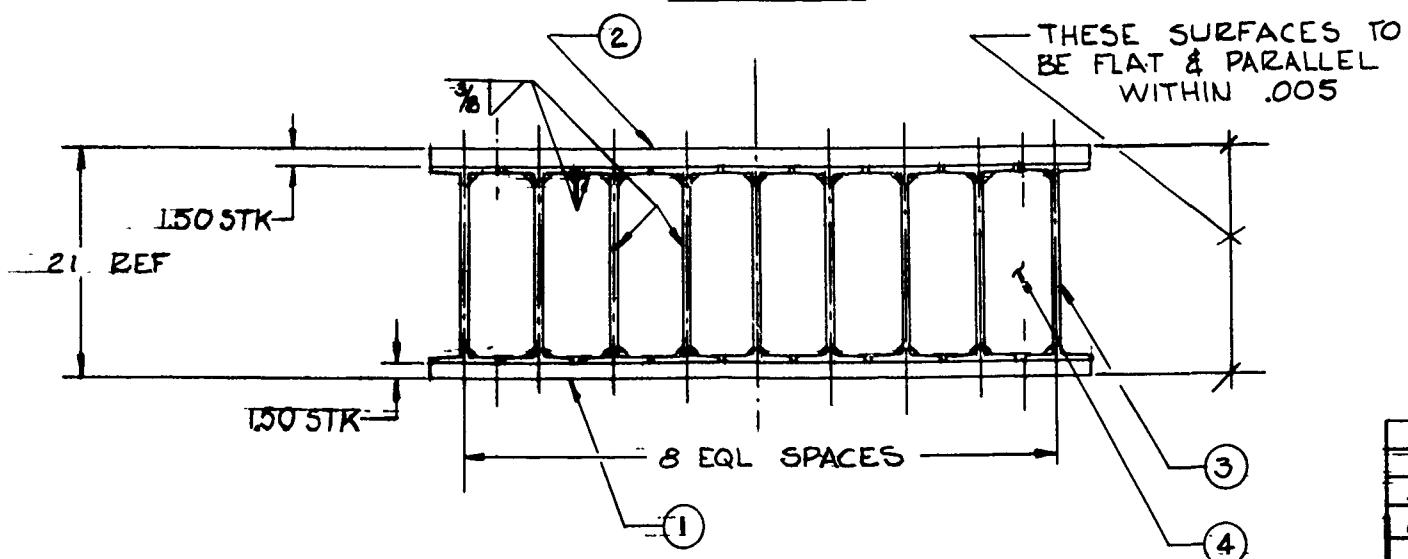
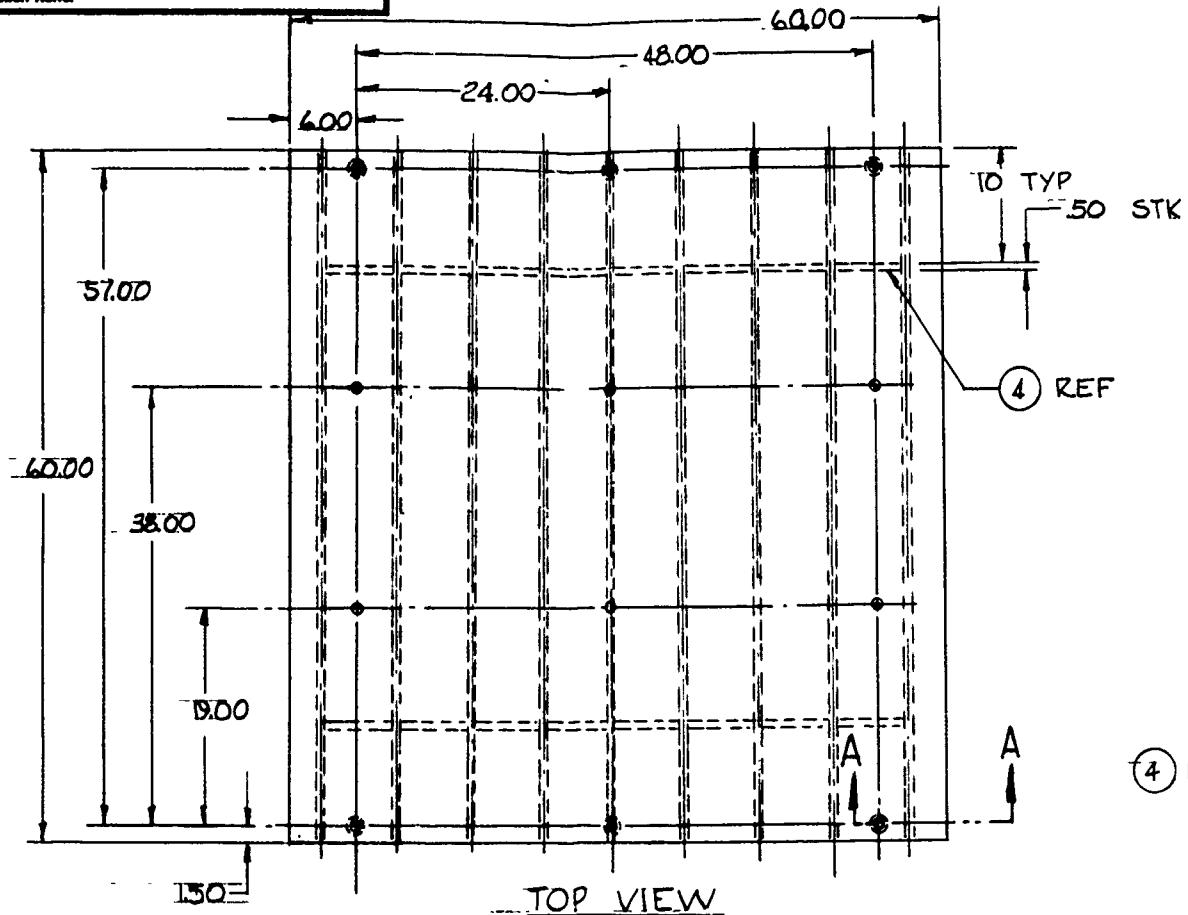


# BEST AVAILABLE COPY



# TABLE COPY

THE INFORMATION AND DESIGN CONTAINED HEREIN WAS GENERATED BY AND IS THE PROPERTY OF GATESAY INC. GATESAY RESERVES THE RIGHT TO REPRODUCE, DISTRIBUTE, OR MAKE AVAILABLE THIS INFORMATION AND DESIGN TO OTHERS. THIS INFORMATION AND DESIGN MAY NOT BE USED OR DISCLOSED BY ANYONE BUT GATESAY INC. THE FOLLOWING DRAWING IS FOR THE EXCLUSIVE USE OF GATESAY INC.



**3. BREAK ALL SHARP EDGES**

**2. PAINT EXTERIOR EXCEPT GROUND SURFACES  
WITH TEMP RESISTANT PAINT (GRAY OR GREEN)**

**1. STRESS RELIEVE WELDMENT BEFORE**

**NOTES: GRINDING.**

NOTE: UNLESS OTHERWISE SPECIFIED

140 DRAFTSPRINT CLASSIC V2000 REV 00000 FORM NO. 0000

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES			
PRIMING	STRUCTURE	ANGLES	FINISH
$\pm \frac{1}{8}$	$\pm \frac{1}{8}$	$\pm \frac{1}{8}$	$\pm \frac{1}{8}$
DO NOT SCALE DRAWINGS			
MATERIAL			
NEXT ASST	USED ON		
APPLICATION			

		REVISIONS		
S/N	DESCRIPTION	DATE	APPROVAL	

**TOP VIEW**

60.00

48.00

10 TYP

.50 STK

(4) REF

**SECTION A-A**  
SCALE  $\frac{1}{2}$

THESE SURFACES TO BE FLAT & PARALLEL WITHIN .005

(3)

(4)

(1)

DRILL 1.12 THRU.  
SPOTFACE FAR SIDE 2 DIA  
TO DEPTH AS REQD TO  
TRUE SURF. BOT SIDE ONLY.  
(OPTION - LOCALLY NOTCH  
I-BEAM FLANGE BEFORE  
WELDING) 6 PLACES

**MATERIALS**

ITEM NO.	QUANTITY	DESCRIPTION	MATERIAL	UNIT WT
4 16	-4	1/8 x 5 1/4 x 17 1/2 PLATE	MILD STL	15.5
3 9	-3	18 x 6 1/4 x 70 1/2 I BEAM		350
2 1	-2	PLATE, 1 1/2 x 60 x 60		1620
1 1	-1	PLATE, 1/8 x 60 x 60 MILD STL		1620

**LIST OF MATERIAL**

ITEM NO.	QUANTITY	DESCRIPTION	MATERIAL	UNIT WT
4 16	-4	1/8 x 5 1/4 x 17 1/2 PLATE	MILD STL	15.5
3 9	-3	18 x 6 1/4 x 70 1/2 I BEAM		350
2 1	-2	PLATE, 1 1/2 x 60 x 60		1620
1 1	-1	PLATE, 1/8 x 60 x 60 MILD STL		1620

**NOTES**

ALL DIMENSIONS SPECIFIED  
DIMENSIONS ARE IN INCHES  
TOLERANCES  
POSITIONS  $\pm \frac{1}{8}$ , DIMENS  $\pm .05$ , ANGLES  $\pm 3^{\circ}$

DO NOT SCALE DRAWINGS

1. SURFACES  
GRAY OR GREEN  
BEFORE

2. EQL SPACES

3. REF

4. REF

5. REF

6. REF

7. REF

8. REF

9. REF

10. REF

11. REF

12. REF

13. REF

14. REF

15. REF

16. REF

17. REF

18. REF

19. REF

20. REF

21. REF

22. REF

23. REF

24. REF

25. REF

26. REF

27. REF

28. REF

29. REF

30. REF

31. REF

32. REF

33. REF

34. REF

35. REF

36. REF

37. REF

38. REF

39. REF

40. REF

41. REF

42. REF

43. REF

44. REF

45. REF

46. REF

47. REF

48. REF

49. REF

50. REF

51. REF

52. REF

53. REF

54. REF

55. REF

56. REF

57. REF

58. REF

59. REF

60. REF

61. REF

62. REF

63. REF

64. REF

65. REF

66. REF

67. REF

68. REF

69. REF

70. REF

71. REF

72. REF

73. REF

74. REF

75. REF

76. REF

77. REF

78. REF

79. REF

80. REF

81. REF

82. REF

83. REF

84. REF

85. REF

86. REF

87. REF

88. REF

89. REF

90. REF

91. REF

92. REF

93. REF

94. REF

95. REF

96. REF

97. REF

98. REF

99. REF

100. REF

101. REF

102. REF

103. REF

104. REF

105. REF

106. REF

107. REF

108. REF

109. REF

110. REF

111. REF

112. REF

113. REF

114. REF

115. REF

116. REF

117. REF

118. REF

119. REF

120. REF

121. REF

122. REF

123. REF

124. REF

125. REF

126. REF

127. REF

128. REF

129. REF

130. REF

131. REF

132. REF

133. REF

134. REF

135. REF

136. REF

137. REF

138. REF

139. REF

140. REF

141. REF

142. REF

143. REF

144. REF

145. REF

146. REF

147. REF

148. REF

149. REF

150. REF

151. REF

152. REF

153. REF

154. REF

155. REF

156. REF

157. REF

158. REF

159. REF

160. REF

161. REF

162. REF

163. REF

164. REF

165. REF

166. REF

167. REF

168. REF

169. REF

170. REF

171. REF

172. REF

173. REF

174. REF

175. REF

176. REF

177. REF

178. REF

179. REF

180. REF

181. REF

182. REF

183. REF

184. REF

185. REF

186. REF

187. REF

188. REF

189. REF

190. REF

191. REF

192. REF

193. REF

194. REF

195. REF

196. REF

197. REF

198. REF

199. REF

200. REF

201. REF

202. REF

203. REF

204. REF

205. REF

206. REF

207. REF

208. REF

209. REF

210. REF

211. REF

212. REF

213. REF

214. REF

215. REF

216. REF

217. REF

218. REF

219. REF

220. REF

221. REF

222. REF

223. REF

224. REF

225. REF

226. REF

227. REF

228. REF

229. REF

230. REF

231. REF

232. REF

233. REF

234. REF

235. REF

236. REF

237. REF

238. REF

239. REF

240. REF

241. REF

242. REF

243. REF

244. REF

245. REF

246. REF

247. REF

248. REF

249. REF

250. REF

251. REF

252. REF

253. REF

254. REF

255. REF

256. REF

257. REF

258. REF

259. REF

260. REF

261. REF

262. REF

263. REF

264. REF

265. REF

266. REF

267. REF

268. REF

269. REF

270. REF

271. REF

272. REF

273. REF

274. REF

275. REF

276. REF

277. REF

278. REF

279. REF

280. REF

281. REF

282. REF

283. REF

284. REF

285. REF

286. REF

287. REF

288. REF

289. REF

290. REF

291. REF

292. REF

293. REF

294. REF

295. REF

296. REF

297. REF

298. REF

299. REF

300. REF

301. REF

302. REF

303. REF

304. REF

305. REF

306. REF

307. REF

308. REF

309. REF

310. REF

311. REF

312. REF

313. REF

314. REF

315. REF

316. REF

317. REF

318. REF

319. REF

320. REF

321. REF

322. REF

323. REF

324. REF

325. REF

326. REF

327. REF

328. REF

329. REF

330. REF

331. REF

332. REF

333. REF

334. REF

335. REF

336. REF

337. REF

338. REF

339. REF

340. REF

341. REF

342. REF

343. REF

344. REF

345. REF

346. REF

347. REF

348. REF

349. REF

350. REF

351. REF

352. REF

353. REF

354. REF

355. REF

356. REF

357. REF

358. REF

359. REF

360. REF

361. REF

362. REF

363. REF

364. REF

365. REF

366. REF

367. REF

368. REF

369. REF

370. REF

371. REF

372. REF

373. REF

374. REF

375. REF

376. REF

377. REF

378. REF

379. REF

380. REF

381. REF

382. REF

383. REF

384. REF

385. REF

386. REF

387. REF

388. REF

389. REF

390. REF

391. REF

392. REF

393. REF

394. REF

395. REF

396. REF

397. REF

398. REF

399. REF

400. REF

401. REF

402. REF

403. REF

404. REF

405. REF

406. REF

407. REF

408. REF

409. REF

410. REF

411. REF

412. REF

413. REF

414. REF

415. REF

416. REF

417. REF

418. REF

419. REF

420. REF

421. REF

422. REF

423. REF

424. REF

425. REF

426. REF

427. REF

428. REF

429. REF

430. REF

431. REF

432. REF

433. REF

434. REF

435. REF

436. REF

437. REF

438. REF

439. REF

440. REF

441. REF

442. REF

443. REF

444. REF

445. REF

446. REF

447. REF

448. REF

449. REF

450. REF

451. REF

452. REF

453. REF

454. REF

455. REF

456. REF

457. REF

458. REF

459. REF

460. REF

461. REF

462. REF

463. REF

464. REF

465. REF

466. REF

467. REF

468. REF

469. REF

470. REF

471. REF

472. REF

473. REF

474. REF

475. REF

476. REF

477. REF

478. REF

479. REF

480. REF

481. REF

482. REF

483. REF

484. REF

485. REF

486. REF

487. REF

488. REF

489. REF

490. REF

491. REF

492. REF

493. REF

494. REF

495. REF

496. REF

497. REF

498. REF

499. REF

500. REF

501. REF

502. REF

503. REF

504. REF

505. REF

506. REF

507. REF

508. REF

509. REF

510. REF

511. REF

512. REF

513. REF

514. REF

515. REF

516. REF

517. REF

518. REF

519. REF

520. REF

521. REF

522. REF

523. REF

524. REF

525. REF

526. REF

527. REF

528. REF

529. REF

530. REF

531. REF

532. REF

533. REF

534. REF

535. REF

536. REF

537. REF

538. REF

539. REF

540. REF

541. REF

542. REF

543. REF

544. REF

545. REF

546. REF

547. REF

548. REF

549. REF

550. REF

551. REF

552. REF

553. REF

554. REF

555. REF

556. REF

557. REF

558. REF

559. REF

560. REF

561. REF

562. REF

563. REF

564. REF

565. REF

566. REF

567. REF

568. REF

569. REF

570. REF

571. REF

572. REF

573. REF

574. REF

575. REF

576. REF

577. REF

578. REF

579. REF

580. REF

581. REF

582. REF

583. REF

584. REF

585. REF

586. REF

587. REF

588. REF

589. REF

590. REF

591. REF

592. REF

593. REF

594. REF

595. REF

596. REF

597. REF

598. REF

599. REF

600. REF

601. REF

602. REF

603. REF

604. REF

605. REF

606. REF

607. REF

608. REF

609. REF

610. REF

611. REF

612. REF

613. REF

614. REF

615. REF

616. REF

617. REF

618. REF

619. REF

620. REF

621. REF

622. REF

623. REF

624. REF

625. REF

626. REF

627. REF

628. REF

629. REF

630. REF

631. REF

632. REF

633. REF

634. REF

635. REF

636. REF

637. REF

638. REF

639. REF

640. REF

641. REF

642. REF

643. REF

644. REF

645. REF

646. REF

647. REF

648. REF

649. REF

650. REF

651. REF

652. REF

653. REF

654. REF

655. REF

656. REF

657. REF

658. REF

659. REF

660. REF

661. REF

662. REF

663. REF

664. REF

665. REF

666. REF

667. REF

668. REF

669. REF

670. REF

671. REF

672. REF

673. REF

674. REF

675. REF

676. REF

677. REF

678. REF

679. REF

680. REF

681. REF

682. REF

683. REF

684. REF

685. REF

686. REF

687. REF

688. REF

689. REF

690. REF

691. REF

692. REF

693. REF

694. REF

695. REF

696. REF

697. REF

698. REF

699. REF

700. REF

701. REF

702. REF

703. REF

704. REF

705. REF

706. REF

707. REF

708. REF

709. REF

710. REF

711. REF

712. REF

713. REF

714. REF

715. REF

716. REF

717. REF

718. REF

719. REF

720. REF

721. REF

722. REF

723. REF

724. REF

725. REF

726. REF

727. REF

728. REF

729. REF

730. REF

731. REF

732. REF

733. REF

734. REF

735. REF

736. REF

737. REF

738. REF

739. REF

740. REF

741. REF

742. REF

743. REF

744. REF

745. REF

746. REF

747. REF

748. REF

749. REF

750. REF

751. REF

752. REF

753. REF

754. REF

755. REF

756. REF

757. REF

758. REF

759. REF

760. REF

761. REF

762. REF

763. REF

764. REF

765. REF

766. REF

767. REF

768. REF

769. REF

770. REF

771. REF

772. REF

773. REF

774. REF

775. REF

776. REF

777. REF

778. REF

779. REF

780. REF

781. REF

782. REF

783. REF

784. REF

785. REF

786. REF

787. REF

788. REF

789. REF

790. REF

791. REF

792. REF

793. REF

794. REF

795. REF

796. REF

797. REF

798. REF

799. REF

800. REF

801. REF

802. REF

803. REF

804. REF

805. REF

806. REF

807. REF

808. REF

809. REF

810. REF

811. REF

812. REF

813. REF

814. REF

815. REF

816. REF

817. REF

818. REF

819. REF

820. REF

821. REF

822. REF

823. REF

824. REF

825. REF

826. REF

827. REF

828. REF

829. REF

830. REF

831. REF

832. REF

833. REF

834. REF

835. REF

836. REF

837. REF

838. REF

839. REF

840. REF

841. REF

842. REF

843. REF

844. REF

845. REF

846. REF

847. REF

848. REF

849. REF

850. REF

851. REF

852. REF

853. REF

854. REF

855. REF

856. REF

857. REF

858. REF

859. REF

860. REF

861. REF

862. REF

863. REF

864. REF

865. REF

866. REF

867. REF

868. REF

869. REF

870. REF

871. REF

872. REF

873. REF

874. REF

875. REF

876. REF

877. REF

878. REF

879. REF

880. REF

881. REF

882. REF

883. REF

884. REF

885. REF

886. REF

887. REF

888. REF

889. REF

890. REF

891. REF

892. REF

893. REF

894. REF

895. REF

896. REF

897. REF

898. REF

899. REF

900. REF

901. REF

902. REF

903. REF

904. REF

905. REF

906. REF

907. REF

908. REF

909. REF

910. REF

911. REF

912. REF

913. REF

914. REF

915. REF

916. REF

917. REF

918. REF

919. REF

920. REF

921. REF

922. REF

923. REF

924. REF

925. REF

926. REF

927. REF

928. REF

929. REF

930. REF

931. REF

932. REF

933. REF

934. REF

935. REF

936. REF

937. REF

938. REF

939. REF

940. REF

941. REF

942. REF

943. REF

944. REF

945. REF

946. REF

947. REF

948. REF

949. REF

950. REF

951. REF

952. REF

953. REF

954. REF

955. REF

956. REF

957. REF

958. REF

959. REF

960. REF

961. REF

962. REF

963. REF

964. REF

965. REF

966. REF

967. REF

968. REF

969. REF

970. REF

971. REF

972. REF

973. REF

974. REF

975. REF

976. REF

977. REF

978. REF

979. REF

980. REF

981. REF

982. REF

983. REF

984. REF

985. REF

986. REF

987. REF

988. REF

989. REF

990. REF

991. REF

992. REF

993. REF

994. REF

995. REF

996. REF

997. REF

998. REF

999. REF

1000. REF

**APPENDIX B**

**PERT CHART, REVISION A**

## APPENDIX B

## PERT CHART

CONTRACT N

MONTHS →

-77-

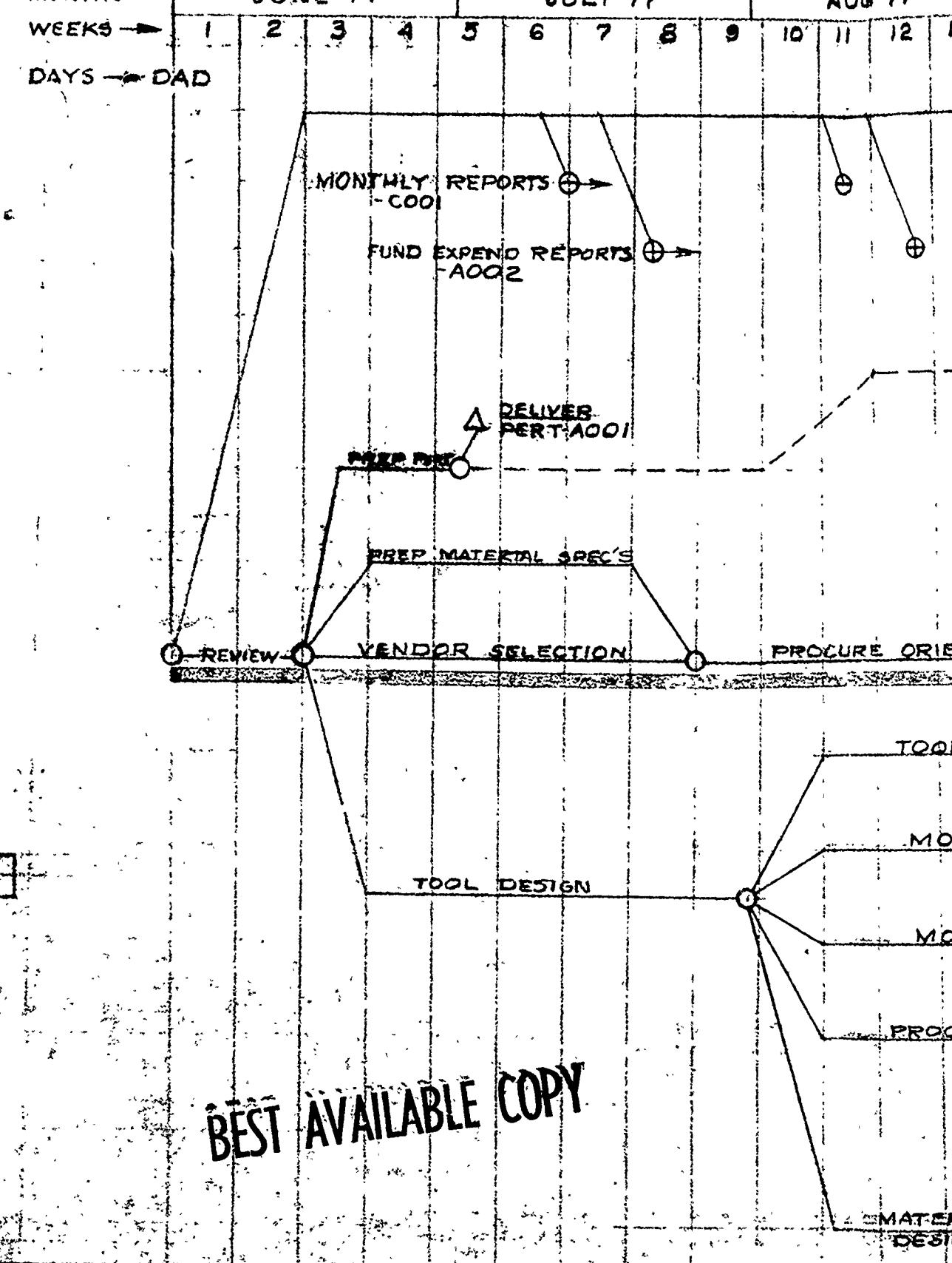
WEEKS →

JUNE 77

JULY 77

AUG 77

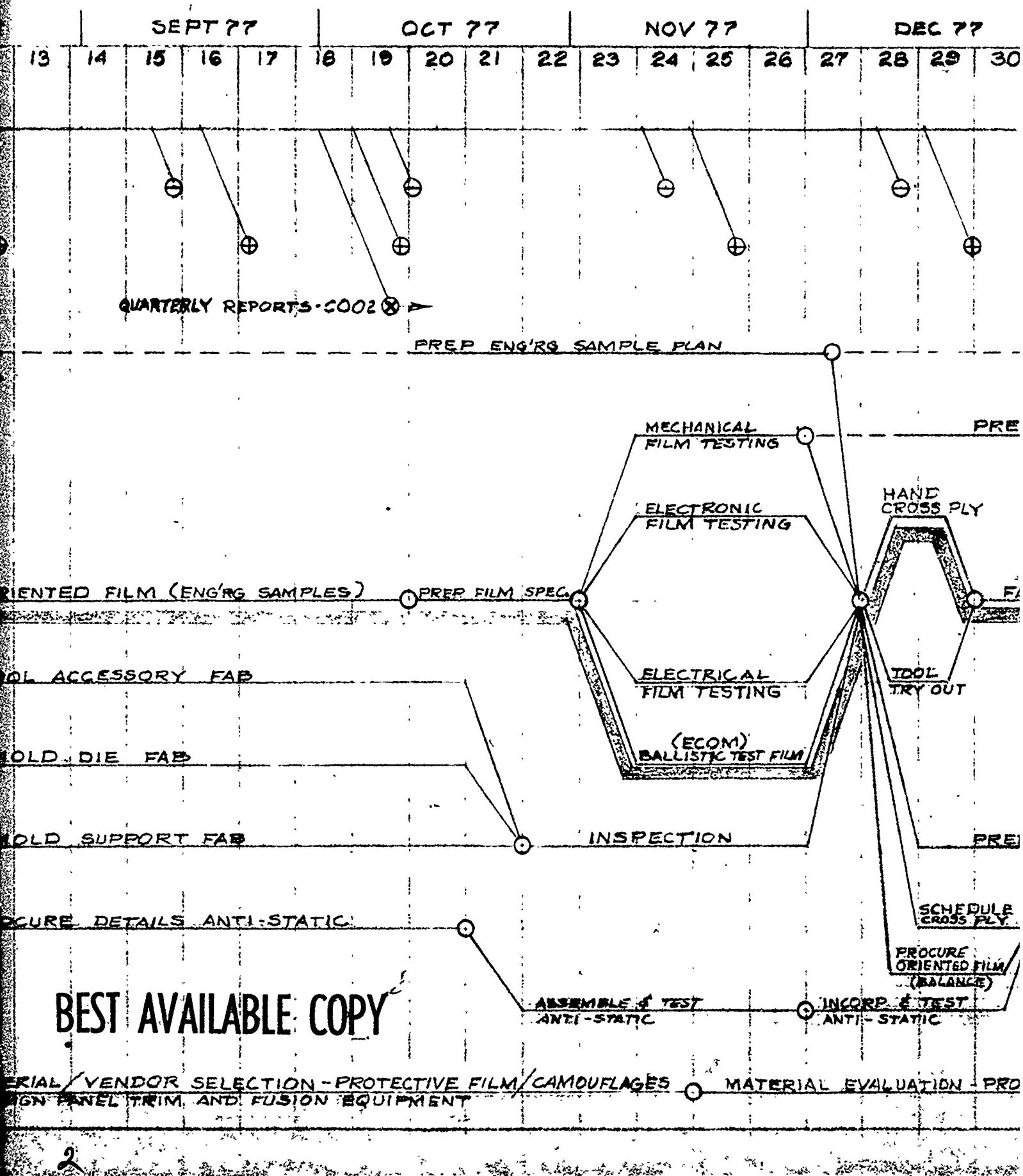
DAYS → DAD



REV A

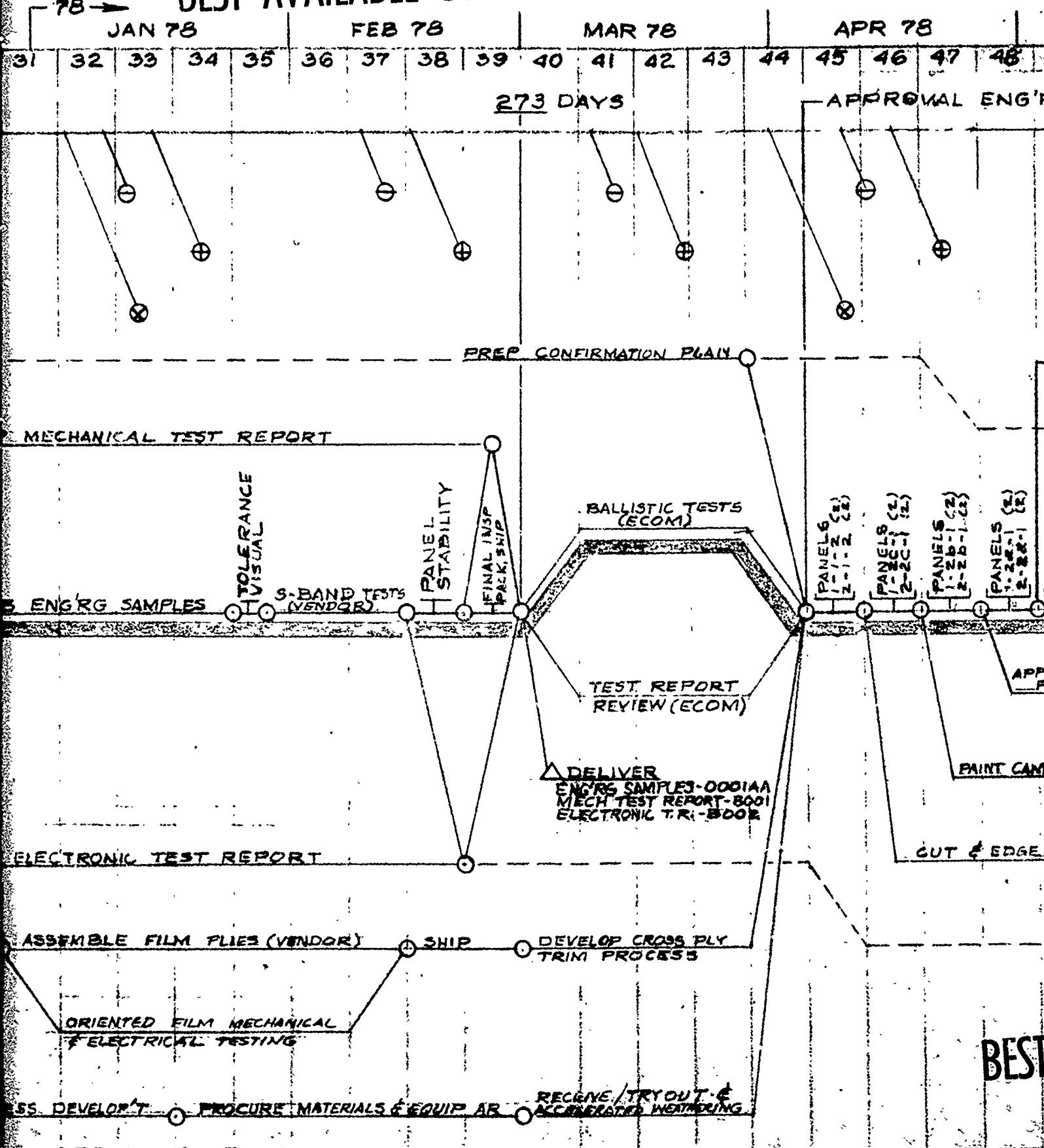
NO DAA807-77-C-0476 USAEC

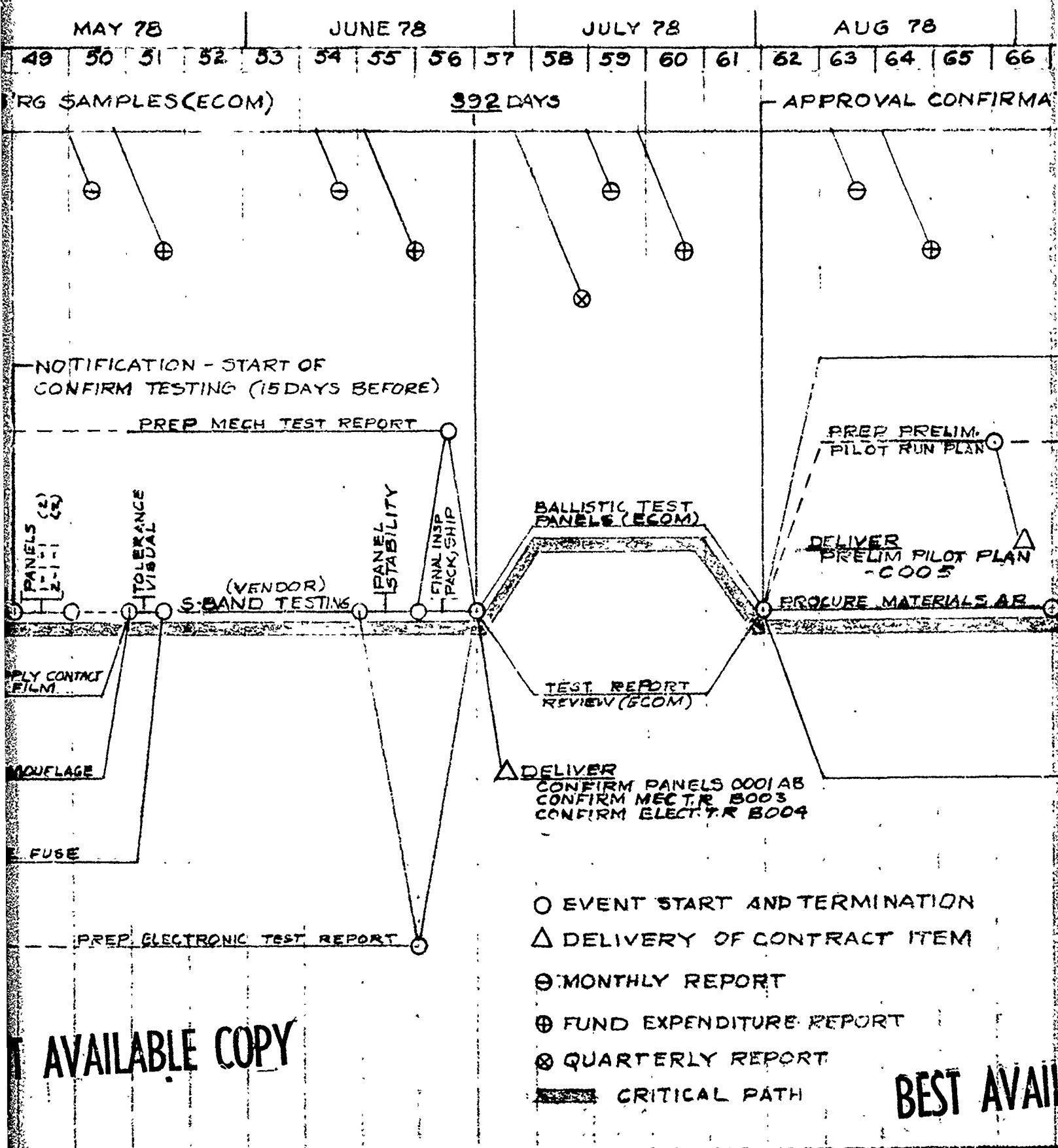
R DOERR 6-24-77



# BEST AVAILABLE COPY

78 →





SEPT 78

OCT 78

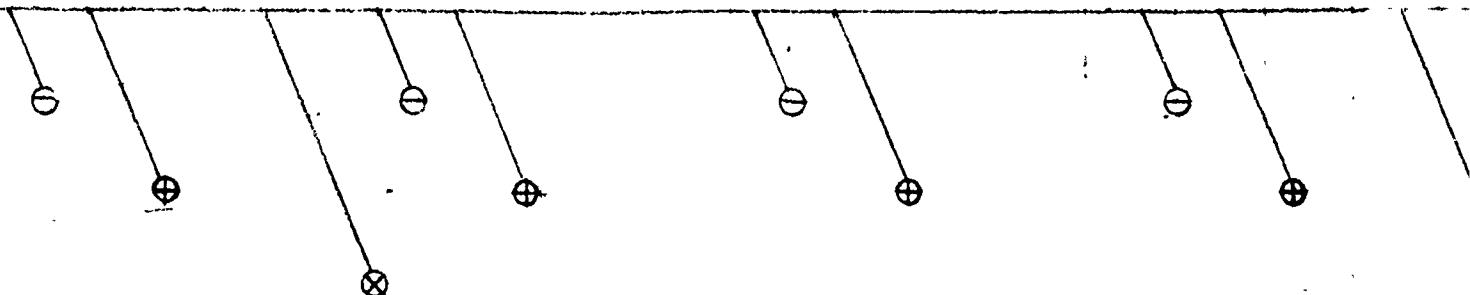
NOV 78

DEC 78

71

66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83

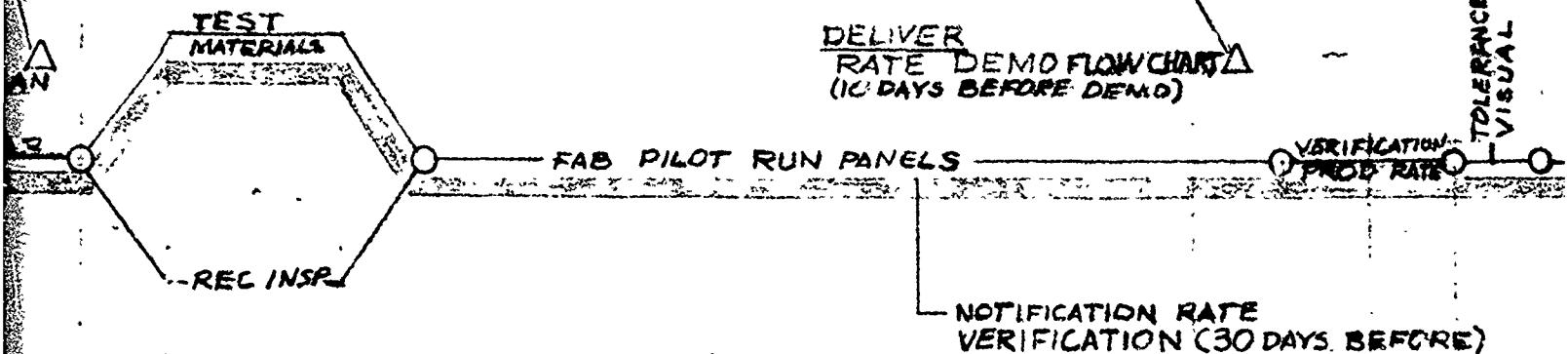
CONFIRMATION PANELS - STYLE &amp; FINISH FOR PILOT RUN (ECOM)



## PREP FINAL REPORT STEP I

PREP RATE FLOW CHART

PREPARE PRODUCT

DELIVER  
RATE DEMO FLOWCHART  
(10 DAYS BEFORE DEMO)

## PREP FINAL REPORT STEP II

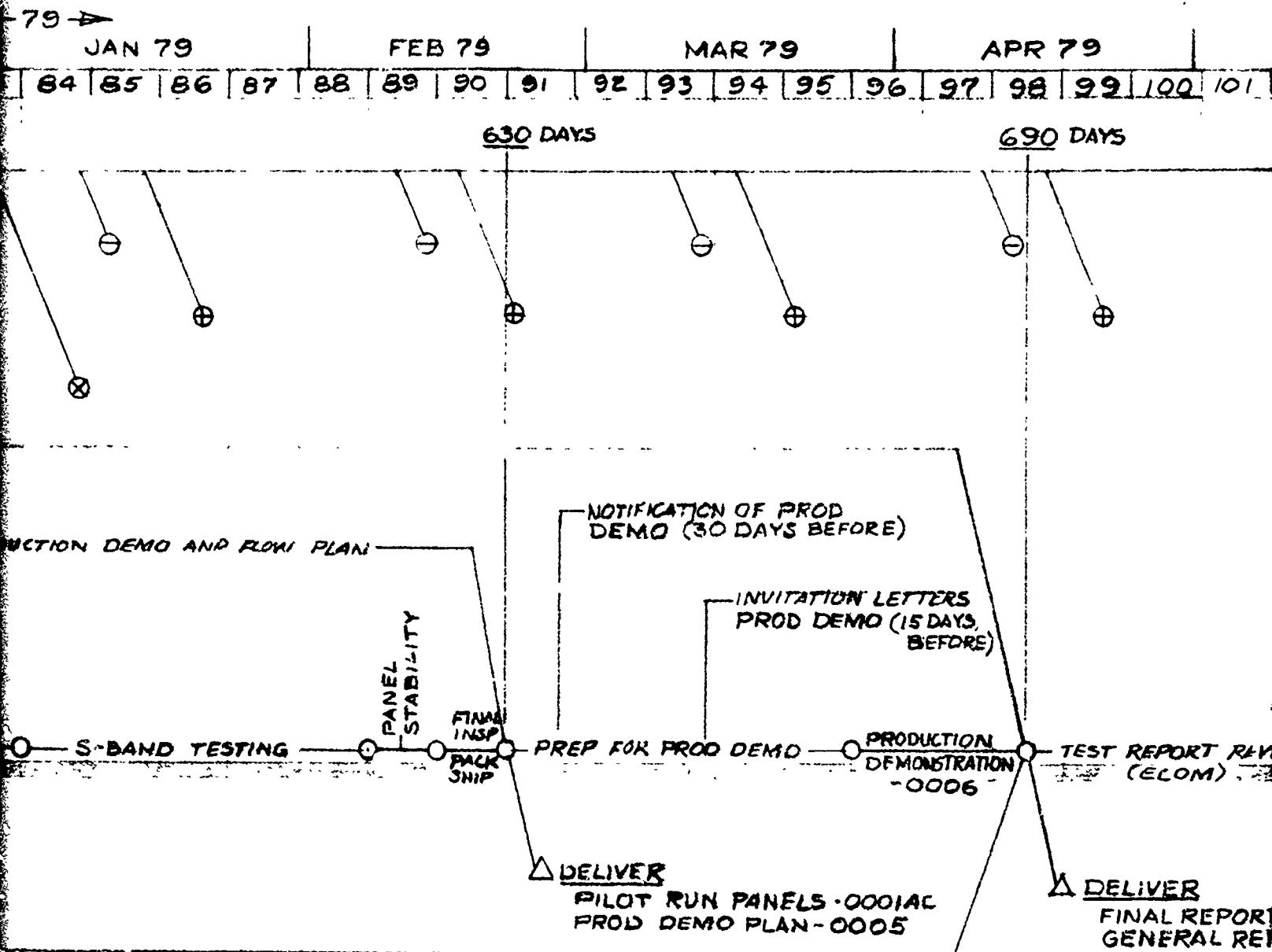
## REVISION

		DATE	APPROVED
A	REVISED ENGINEERING SAMPLE DELIVERY FROM 210 TO 273 DAYS AND CONFIRMATION SAMPLE DELIVERY FROM 330 TO 392 DAYS IN ORDER TO PROVIDE FOR MATERIAL TESTING PRIOR TO ORDERING CROSS PLIED MATERIAL	8-8-77	R DOERR PROPOSED REVISION 7-10-77

AVAILABLE COPY

BEST AVAILABLE COPIES

5



APPROVAL	
W	ELOM
R	TELECON APPROVAL
D	PROPOSED REVISION
D	D. BISER
	8-4-77

BEST AVAILABLE COPY

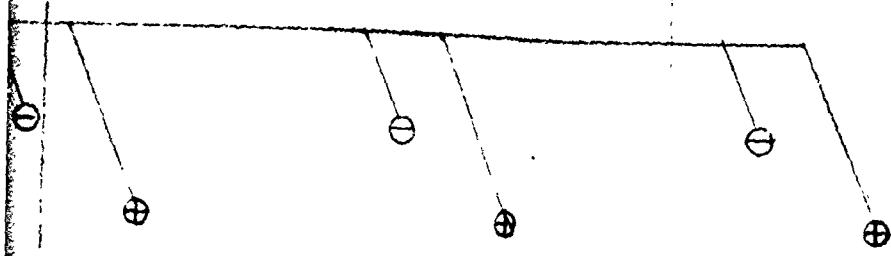
COPY

PR 79

MAY 79

98 99 100 101 102 103 104 105

690 DAYS



TEST REPORT REVIEW  
TEST REPORT  
(ECOM) REVISIONS ARE

DELIVER  
FINAL REPORT STEP I-COO3  
GENERAL REPORT STEP II(DRAFT)

DELIVER  
GENERAL REPORT STEP II - COO4

REV A

COPY

BEST AVAILABLE COPY

B-1